8. Example of a HEP Application

The purpose of this chapter is to illustrate the use of HEP forms (Appendix A) in the development and subsequent use of HEP data in three separate but related planning activities: 1) wildlife habitat assessments, including both baseline and future conditions (Chapter 5); 2) trade-off analyses (Chapter 6); and 3) compensation analyses (Chapter 7). Example applications of these planning activities are discussed separately, in the order mentioned, to illustrate the different processes required. This order is approximately the same chronology followed in most land and water use studies because each planning activity is a prerequisite to the next. For example, baseline studies must precede impact assessments, impact assessments must precede trade-off analyses, and trade-off analyses precede compensation studies.

The example study involves a proposed alteration of a medium-sized warmwater stream segment, and the predicted alterations in adjoining terrestrial habitat resulting from hydrological changes and changes in ownership and management.

8.1 Habitat assessments. Habitat assessment using HEP involves the determination or prediction of HU's for selected evaluation species (Chapter 5). There are two steps in the assessment process: 1) baseline determinations that produce measures of HU's at one point-in-time; and 2) future assessments which project the net changes in HU's for a specified future period of time.

A. Baseline assessments. Baseline assessments are used to describe existing habitat conditions (Section 5.1) and normally involve development of a cover type map of the study area. Example cover type-area data that would be derived from a map are presented in Table 8-1.

Table 8-1. Cover types and area data for example study.

Cover type	Area (acres)
Deciduous forest	1,000
Coniferous forest	1,500
Grassland	500
Residential woodland	800
Medium-sized warmwater stream	50

Both socioeconomic and ecologically important species were selected for this example through a combination of techniques discussed in Chapter 3. Table 8-2 identifies the eight evaluation species selected for this example and indicates cover type usage by each.

Table 8-2. Example study area evaluation species and cover types.

Evaluation species	Cover types				
	Deciduous forest	Coniferous forest	Grassland	Residential woodland	Medium-sized warmwater stream
White-tailed deer	X	X	X		
Ruffed grouse	X				
Red fox	X	X	X		
Yellow-rumped warbler	X			X	
Spotfin shiner					X
Channel catfish					X
Sunfishes (*Lepomis* spp.)					X
Smallmouth bass (stream)					X

Area and HSI values for all evaluation species were determined and entered on an appropriate Form B (Figure 8-1) to determine HU's. However, in some situations, supplementary Forms A-1 and A-2 may be required in order to complete Form B.

If a suitability index is calculated at individual sample sites within each cover type, Form A-1 is used to record site scores and to calculate

8. Example of a HEP Application

1. Study
EXAMPLE

2. Proposed action
Baseline condition

3. Target year
Baseline (1980)

4. Evaluation species	5. Area of available habitat	6. Evaluation species' mean Habitat Suitability Index in available habitat	7. Habitat Units in study area
White-tailed deer	3000	0.6	1800
Ruffed grouse	1000	0.7	700
Red fox	3000	0.4	1200
Yellow-rumped warbler	1800	0.4	720
Spotfin shiner	50	0.4	20
Channel catfish	50	0.3	15
Lepomis spp.	50	0.6	30
Smallmouth bass (stream)	50	0.8	40
		Total	8. 4525

Figure 8-1. Form B displaying baseline data.

8. Example of a HEP Application

1. Study EXAMPLE	**2. Proposed action** Plan A
3. Target year Baseline	**4. Cover type or subarea** Warmwater stream-Riffle
5. Area 30	**6. Date** July 1, 1980

7. Evaluation species	**8. HSI of sample sites** 01	02	03	04	05	06	07	08	09	10	**9. Mean HSI in cover type**
Spotfin shiner	0.2	0.2	0.4	0.4							0.3
10. Site scores	0.2	0.2	0.4	0.4							**11. Mean** 0.3

Figure 8-2. Sample site HSI values for the spotfin shiner in riffle subareas. (Form A-1)

8. Example of a HEP Application

1. Study EXAMPLE	**2. Proposed action** Plan A
3. Target year Baseline	**4. Cover type or subarea** Warmwater stream-Pool
5. Area 20	**6. Date** July 1, 1980

7. Evaluation species	**8. HSI of sample sites** 01	02	03	04	05	06	07	08	09	10	**9. Mean HSI in cover type**
Spotfin shiner	0.6	0.6	0.4	0.4							0.5
10. Site scores	0.6	0.6	0.4	0.4							**11. Mean** 0.5

Figure 8-3. Sample site HSI values for the spotfin shiner in pool subareas. (Form A-1)

1. Study EXAMPLE	2. Proposed action Plan A
3. Target year Baseline	4. Cover type or subarea Deciduous forest
5. Area 1000	6. Date January 1980

7. Evaluation species	8. HSI of sample sites										9. Mean HSI in cover type
	01	02	03	04	05	06	07	08	09	10	
White-tailed deer (fall/winter food)	0.5	0.6									0.55
White-tailed deer (cover)	0.7	0.7									0.70
Red fox (reproductive)	0.3	0.5									0.40
Ruffed grouse	0.8	0.8									0.80
10. Site scores	0.57	0.65									11. Mean 0.61

Figure 8-4. Sample site HSI scores for deciduous forest. (Form A-1)

8. Example of a HEP Application

1. Study: EXAMPLE		2. Proposed action: Plan A	
3. Evaluation species: Yellow-rumped warbler		4. Sample dates: January 1980	5. Target year: Baseline
6. Cover type or subarea	**7. Area**	**8. Mean HSI of area**	**9. Available Habitat Units (Block 7 x Block 8)**
Deciduous forest	1000	0.5	500
Residential woodland	800	0.3	240
	10. 1800		11. 740

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{740}{1800} = 0.41 = 0.4$

Figure 8-5. Determination of weighted mean HSI for the yellow-rumped warbler. (Form A-2) mean suitability indices. Figures 8-2 and 8-3 illustrate the use of Form A-1 for the spotfin shiner in two different subareas of the stream cover type. Figure 8-4 illustrates the use of Form A-1 for white-tailed deer and red fox, two species for which HSI models supply only partial suitability scores (i.e., not all life requisites are supplied by deciduous forest), and the ruffed grouse.

The HSI for available habitat must be aggregated if the study area is divided into cover types or subareas for analysis purposes. The aggregation technique depends on the species habitat use patterns. If interspersion between cover types is not important, Form A-2 may be used to aggregate cover type indices. The yellow-rumped warbler is an example of a species found in two cover types--deciduous forest and residential woodland (Table 8-2). Each cover type provides all life requisites and interspersion between the two is not a significant consideration for any individual warbler. The HSI of available habitat for the yellow-rumped warbler becomes a simple weighted mean (i.e., weighted by area of each cover type) for the two cover types (Figure 8-5). Figure 8-6 represents the same process for the spotfin shiner which uses subareas of a single aquatic cover type. Area and HSI values from each subarea (Figures 8-2 and 8-3) were combined on Form A-2 to obtain a weighted mean HSI value of 0.4 for the spotfin shiner. Data obtained in this manner from Form A-2 were entered on Form B. If interspersion between cover types is important, the habitat model must contain the aggregation method.

Baseline HU data are used: 1) to make point in time comparisons; 2) as a reference point for impact assessments; or 3) for entry into the Human Use and Economic Evaluation (104 ESM). Baseline assessments may involve the comparisons of two or more areas; either the HU or HSI data for evaluation species may be used, depending upon study objectives. If, for example, the study objective is to select an area for development in order to minimize the impact on an evaluation species such as white-tailed deer, then the user would select that area with the least number of white-tailed deer HU's for development. If the study objective is to prevent losses of optimum habitat, then the user may evaluate the HSI values to determine which area is of highest quality.

When impact assessments are desired, the baseline year HU data becomes the common reference point on which future comparisons are based (Chapter 5). The relationship (assumed or proven) between HU and carrying capacity provides an entry point into Human Use and Economic Evaluation (104 ESM). Habitat Unit data, based on sustained yield and harvest rates, are used to determine upper limits of human use; an example of this relationship is found in Section 4.1, 104 ESM.

8. Example of a HEP Application

1. Study EXAMPLE	2. Proposed action Plan A	
3. Evaluation species Spotfin shiner	4. Sample dates July 1, 1980	5. Target year Baseline

6. Cover type or subarea	7. Area	8. Mean HSI of area	9. Available Habitat Units (Block 7 x Block 8)
Pool	20	0.5	10
Riffle	30	0.3	9
	10. 50		11. 19

12. Mean HSI for available habitat = $\frac{\text{Block 11}}{\text{Block 10}} = \frac{19}{50} = 0.38 = 0.4$

Figure 8-6. Determination of weighted mean HSI for the spotfin shiner. (Form A-2)

B. Impact assessments. An impact assessment requires an analysis of the net impacts of a proposed action in terms of change in HU's through a specified period of time. Net impacts are obtained by comparing predicted future conditions without any action (e.g., current land and water use trends continue) with expected future conditions resulting from the proposed action. Therefore, two separate analyses of habitat changes through time are required.

To illustrate the impact assessment process, 7 target years were selected over a 115 year analysis period. In practice, a Form B, and appropriate supplemental Form A's, would be completed for each target year. All target year HSI and area data are compiled on a separate Form C for each evaluation species. However, only data for the smallmouth bass (stream) are presented to illustrate the calculation of AAHU's on Form C. Each evaluation species would be treated by the same process in an actual impact assessment. The proposed stream alteration is expected to affect both HSI and area for the smallmouth bass (Figure 8-7). Land acquisition, and accompanying land use changes which alter HSI, are predicted to begin at target year 1 and to continue until target year 10. Additional land use changes affecting both HSI and area are predicted to occur during target year 11. Construction during target year 15 is predicted to further alter HSI and area. Life of the project for benefit/costs analyses begins at target year 15 and continues for 100 years. Target years 50 and 115 reflect predicted changes in HSI and area that result from natural recovery processes within the stream.

The calculations on Form C (Figure 8-7) indicate that for the smallmouth bass (stream) 18.8 AAHU's would be available with the proposed action. The net impact to habitat for this evaluation species is calculated by comparing Form C data for the future with a proposed action (Figure 8-7) and the future without the proposed action using Form D. The completion of each Form C requires prior completion of the appropriate Form B's and supplemental Form A's.

Figure 8-8 presents the smallmouth bass (stream) data for future-with and future-without the proposed action, plus comparable example data for all other evaluation species obtained (in practice) from their respective Form C's. Net impacts to smallmouth bass habitat (stream) can be expressed as 26.0 AAHU's per year for the life of the project. Completion and analysis of one Form D for each proposed action under consideration completes the impact assessment. Alternative actions can be compared on: 1) the relative magnitude of HU changes for any species or set of species; and 2) the species impacted since these may differ between alternatives. When different species are impacted by different alternatives, interpretations are required.

1. Study name EXAMPLE	2. Study area	3. Proposed action Plan A

4. Evaluation species	5. HSI and area by target year (TY)													
Smallmouth Bass (Stream)	Baseline		TY 1		TY 10		TY 11		TY 15		TY 50		TY 115	
	HSI	Area	HSI	Area	HSI	Area	HSI	Area	HSI	Area	HSI	Area	HSI	Area
	0.8	50	0.7	50	0.6	50	0.4	48	0.2	45	0.3	46	0.4	48

6.

$$\text{Total number of HU years} = (T_2-T_1)\left[\left(\frac{A_2H_2 + A_1H_1}{3}\right)+\left(\frac{A_1H_2 + A_2H_1}{6}\right)\right]$$

where: T_1 = First year of time interval
T_2 = Last year of time interval
A_1 = Habitat area at first target year
A_2 = Habitat area at second target year
H_1 = HSI at the first target year
H_2 = HSI at the second target year

	Calculations	7. Habitat Units between target years
6A.	$1\left[\left(\frac{50 \times 0.7 + 50 \times 0.8}{3}\right) + \left(\frac{50 \times 0.7 + 50 \times 0.8}{6}\right)\right] = 1\ (25 + 12.5)$	37.5
6B.	$9\left[\left(\frac{50 \times 0.6 + 50 \times 0.7}{3}\right) + \left(\frac{50 \times 0.6 + 50 \times 0.7}{6}\right)\right] = 9\ (21.7 + 10.8)$	292.5
6C.	$1\left[\left(\frac{48 \times 0.4 + 50 \times 0.6}{3}\right) + \left(\frac{50 \times 0.4 + 48 \times 0.6}{6}\right)\right] = 1\ (16.4 + 8.1)$	24.5
6D.	$4\left[\left(\frac{45 \times 0.2 + 48 \times 0.4}{3}\right) + \left(\frac{48 \times 0.2 + 45 \times 0.4}{6}\right)\right] = 4\ (9.4 + 4.6)$	56.0
6E.	Total from additional target years 399 + 1072.5	1471.5
	Sum of Habitat Units	8. 1882.0

9. Life of project 100	10. Block 8 ÷ Block 9 18.8

Figure 8-7. Determination of AAHU's available for a smallmouth bass (stream) under plan A. (Form C)

1. Study EXAMPLE		2. Proposed action Plan A	
3. Evaluation species	4. Average Annual Habitat Units		5. Change in Average Annual Habitat Units
	a. Future with action	b. Future without action	
White-tailed deer	1278	2000	-722
Ruffed grouse	300	700	-400
Red fox	1000	1120	-120
Yellow-rumped warbler	150	700	-550
Spotfin shiner	25	22	+3
Channel catfish	13	16.5	-3.5
Lepomis spp.	26	33	-7.0
Smallmouth bass (stream)	18.8	44.8	-26.0
		Total	6. -1825.5

Figure 8-8. Determination of net change in AAHU's resulting from plan A. (Form D)

The use of HEP focuses on evaluation species. However, these data can be projected from evaluation species to a larger segment of the wildlife community if adequate care is given to the species selection process (Chapter 3). For example, if habitat for a species representing a particular guild is altered, inferences about other species within that guild can be made.

8.2 Trade-off analysis. Trade-off analysis is an optional treatment of data, and occurs after Forms B through D, plus any necessary Forms A-1 and A-2, are completed for the proposed action being analyzed. Examples of completed Forms A-1 through D were provided earlier and are not repeated here. Forms E, F, and G-1 are completed for those evaluation species for which a trade-off analysis is desired. In this example, the decision was made to undertake a separate trade-off analysis for terrestrial and aquatic species. Therefore, two sets of Forms E, F, and G-1, one for terrestrial and one for aquatic species, would be completed. Figures 8-9, 8-10, and 8-11 illustrate the use of Forms E, F, and G-1, respectively, for terrestrial evaluation species only.

Trade-off analyses combine value judgments (RVI's) with a biological index (AAHU's) to display relative AAHU's. These relative AAHU's display, from the standpoint of user-defined socioeconomic and environmental criteria, which evaluation species are most impacted. In this example, the greatest impact, in terms of relative AAHU's, would occur to the yellow-rumped warbler (Figure 8-11).

8.3 Compensation analysis. Compensation studies identify measures that would offset unavoidable HU losses due to a proposed land use action. This section illustrates the evaluation of four management plans to meet specific compensation goals (Chapter 7). Prior completion of Forms B (plus supplementary Forms A-1 and A-2 if appropriate), C, and D are required for the proposed action (Plan A) and each management plan.

A. Goal 1. In-kind Compensation. In-kind compensation is intended to replace losses of AAHU's, for an evaluation species, with equal gains in AAHU's for that same species. Goal 1 (in-kind, no trade-off) may be impossible to completely achieve; it is usually necessary to develop several plans to determine which one best meets this compensation goal. Two plans, Stream Management Plan 1 (Figure 8-12) and Stream Management Plan 2 (Figure 8-13), are provided for management of the stream to meet Goal 1. Both plans are based on a decision by the user to only attempt to compensate in-kind (Goal 1, Chapter 7). Relative Value Indices are not used in this case; Form H is completed by using data from a Form D for the proposed action, and a Form D for the management plan under evaluation. When trying to meet Goal 1, only species negatively impacted by the proposed action are listed on Form H. If Stream Management Plan 1 is implemented, 24 acres of stream habitat would

1. Study

EXAMPLE (Terrestrial only)

2. Ranking criteria	**3.** (1)	Ranking criteria (2)	(3)	(4)	(5)	(6)	**Dummy**	**4. Sum**	**6. Relative weight**
(1) Scarcity	**XXXXX**	0	1				**1.0**	2.0	0.33
(2) Vulnerability	1	**XXXXX**	1				**1.0**	3.0	0.50
(3) Replaceability	0	0	**XXXXX**				**1.0**	1.0	0.17
(4)				**XXXXX**			**1.0**		
(5)					**XXXXX**		**1.0**		
(6)						**XXXXX**	**1.0**		
Dummy criteria	**0**	**0**	**0**	**0**	**0**	**0**	**XXXXX**	**0.0**	**0.00**
								5. Total 6.0	**7. Total weight** 1.0

Figure 8-9. Example ranking of RVI criteria for terrestrial Evaluation Species. (Form E)

8. Example of a HEP Application

1. Study EXAMPLE

2. Evaluation species	3. Relative weight of ranking criteria						5. Relative value	6. Relative Value Index
	1	2	3	4	5	6		
	0.33	0.50	0.17					
	4. Relative importance of each ranking criterion to each evaluation species.							
White-tailed deer	0.5	0.8	0.2					
Product	0.17	0.4	0.03				0.60	0.60
Ruffed grouse	0.8	0.9	0.4					
Product	0.26	0.45	0.07				0.78	0.78
Red fox	0.6	0.2	0.3					
Product	0.2	0.10	0.05				0.35	0.35
Yellow-rumped warbler	1.0	1.0	1.0					
Product	0.33	0.50	0.17				1.0	1.0
Product								
Product								
Product								
Product								
Product								
Product								

Figure 8-10. Determination of RVI's for terrestrial Evaluation Species. (Form F)

8. Example of a HEP Application

1. **Study** EXAMPLE		2. **Proposed action** Plan A	
3. **Evaluation species**	4. **Change in** Average Annual Habitat Units	5. **Relative** Value Indices	6. **Change in relative** Average Annual Habitat Units
White-tailed deer	-722	0.6	-433
Ruffed grouse	-400	0.78	-312
Red fox	-120	0.35	- 42
Yellow-rumped warbler	-550	1.000	-550
		Total change in relative Average Annual Habitat Units.	7. -1337

Figure 8-11. Determination of change in relative AAHU's for terrestrial Evaluation Species. (Form G-1)